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## Descriptions of new species of *Apistogramma* (Teleostei: Cichlidae) from the Rio Mamoré system in Bolivia

by

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### Introduction

With more than fourty valid and numerous undescribed species already known to scientists and aquarists, *Apistogramma* Regan is the largest genus of South American cichlids. Two species had already been known from the Rio Mamoré system in Bolivia. They were collected by Karl-Heinz Lüling in 1966, and incorrectly identified by Hermann Meinken as *Apistogramma borellii* (Regan) and *Apistogramma amoena* (Cope). Sven O. Kullander reexamined the specimens identified as *Apistogramma borellii* and described them as *Apistogramma luelingi* in 1976. I have reexamined the specimens identified as *Apistogramma amoena* and found them to represent another new species. It is conspecific with a single specimen more recently (Kullander 1983 a) figured but not named. Collections made by Horst Linke and Wolfgang Staeck in the summer of 1983 made available fresh material of this and another undescribed species from the Rio Mamoré system. This material forms the basis for the descriptions given below.

Both species were figured in a popular book (Linke & Staeck 1984) and are likely to become distributed among aquarists.

### Methods

Measurements were taken with a Mitutoyo calliper reading to 0.05 mm. Otherwise the methods are as described in Kullander (1980 b,c), but as I always get shorter measurements for snout length and check depth and longer measurements for caudal peduncle length in all specimens also measured by Kullander, those differences indicate slightly different manners of taking those measurements. Caudal peduncle length is taken along the ventral edge. Abbreviations used are BMNH = British Museum of Natural History, London, IRSNB = Institut Royal des Sciences Naturelles de Belgique, Bruxelles, MZUSP = Museu de Zoologia da Universidade de São Paulo, NRM = Swedish Museum of Natural History, Stockholm, SMF = Senckenberg Museum, Frankfurt am Main, ZFMK = Zoologisches Forschungsinstitut und Museum Alexander Koenig, Bonn, ZMA = Zoölogisch Museum, Amsterdam, ZMH = Zoologisches Museum, Hamburg; SL = standard length, TL = total length, CPL = caudal peduncle length, CPD = caudal peduncle depth.

*Apistogramma staecki* n. sp.

*Apistogramma* sp.: Linke & Staeck (1984: 128).

*Apistogramma staecki* Koslowski, in Busse (1984: 223; nomen nudum).

Holotype: ZFMK 13400, ♂, 20.8 mm SL; Bolivia, south of the town Trinidad, „Lagunen beiderseits der Straße von Trinidad ca. 10 km südlich in Richtung El Colegio und Loreto”, sta.B11, about 64°51'W—14°57'S, leg. H. Linke & W. Staeck, 12. VII. 1983.

Paratypes: ZFMK 13401—13404, 1♂, 20.8 mm SL, 3♀, 17.7—20.6 mm SL; SMF 18855a—h, 1♂, 16.8 mm SL, 5♀, 16.1—20.4 mm SL, 2 sex indet., 14.7—15.9 mm SL; MZUSP 28725, 2♀, 15.0—19.4 mm SL; NRM A 83/1983282.3053, 1♂, 20.9 mm SL, 6♀, 15.7—18.7 mm SL, all same data as holotype. ZFMK 13405—13410, 1♂, 20.7 mm SL, 3♀, 19.5—19.9 mm SL, 2 sex indet., 15.8—17.5 mm SL; Bolivia, east of the town Trinidad, „Lagunen und Restflußwasser an der Straße von Trinidad nach Osten ca. 10 km in Richtung Peroto”, sta. B 10, about 64°48'W—14°49'S, leg. H. Linke & W. Staeck, 12. VII. 1983.

I have also examined two ♂ (32.1 mm SL, ZFMK 13411 and 30.3 mm SL, ZFMK 13466) and one ♀ (26.8 mm SL, ZFMK 13412) raised in aquaria, but collected at one of the two localities given above. These specimens were studied only with regard to fin dimorphism in adults of both sexes and development of lower lateral line in adult males.<sup>1</sup>

**Etymology:** The species is dedicated to Dr. Wolfgang Staeck, one of the collectors of the type material.

**Diagnosis:** A moderately elongate species of *Apistogramma* with developed sexual fin dimorphism, distinguished from all other species of the genus, except those of the *steindachneri* group (Kullander, 1982b), by having bar 5, bar 6 and frequently bar 4 split vertically into two narrow stripes (in freshly preserved material). From the *steindachneri* species group *Apistogramma staecki* differs in lacking a flank spot, having numerous gill-cover scales, few or no canals in the lower lateral line and a lower number of infraorbital lateralis foramina.

**Description:** Morphometric data are summarized in Table 1. Figures 1—4 show body shape and coloration of preserved and living specimens. The

<sup>1</sup> A series of *Apistogramma* from the National Museum of Natural History, Washington D. C. (USNM), arrived after the manuscript had gone to print. It includes 8 specimens of *Apistogramma staecki*: USNM 235635, 4♂, 22.3—31.8 mm SL, 4♀, about 19.5—24.9 mm SL; South America, Brazil, Guaporé drainage, between Guajara Mirim and Mato Grosso, leg. B. von Graeve, 1970. The material agrees quite well with the Mamoré material, but bars are faded except in the smallest male, in which bars 4—6 are split. Three females have a small lateral spot. Biggest male with obscure caudal spot pigmentation; not vertically extended and not distinctly separate from the lateral band. Males with caudal-fin streamers, biggest male also with slightly produced dorsal-fin lappets, third longest, nearly twice spine length. D. XV. 6 (1), XVI. 6 (7). Lower lateral line with 1 (3), 2 (1), 4 (1), 5 (1) and O (2) canals.

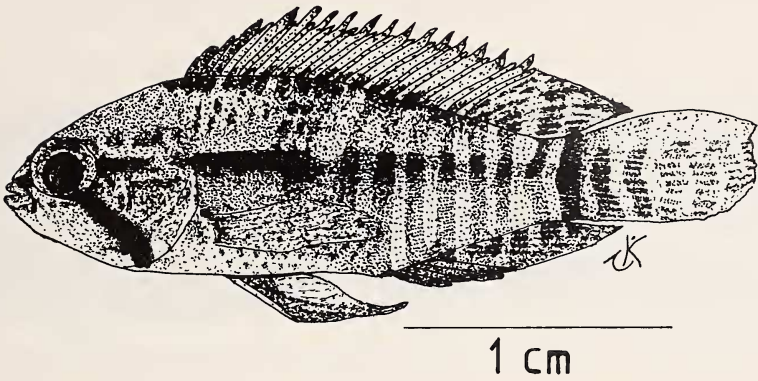


Fig. 1: *Apistogramma staecki* n. sp., sketch of the holotype ZFMK 13400.

following data are from all type specimens. Frequency is given in parentheses. Individual variation in characters studied is very slight.

Body moderately elongate, similar to that of *A. luelingi* which, however, is slightly deeper. Mouth bluntly pointed, interorbital very wide. Sexual dimorphism not apparent in preserved wild specimens, but noted in specimens from the same localities grown up in aquaria: males growing bigger than females (32.1 mm SL, about 42.3 mm TL, compared to 26.8 mm SL, 35.3 mm TL) and developing caudal fin streamers and pointed or slightly produced anterior dorsal spine membranes.

Scales in a lateral series: 22 (22) or 23 (2); in a series above that including lower lateral line. All scales ctenoid except between orbits at predorsal midline, from pelvic fin anteriorly on chest, anteriorly on cheek, on interoperculum and posteriormost scale of upper subopercular series and scales of lower subopercular series, which are cycloid. Cheek scales in 2–3 rows, mode 3. Numerous gill-cover scales: Squ. op.: 12–18,  $\bar{x}$  = 14.3 (n = 28); Squ. iop. 1–4, mode 3, lower counts probably due to loss of scales; Squ. sop. 5–11, usually 7–9,  $\bar{x}$  = 8.3 (n = 27). Upper lateral line in third scale series above that including lower lateral line,  $2\frac{1}{2}$  (anteriorly) to  $\frac{1}{2}$  (posteriorly) scale distant from dorsal fin base. Upper lateral line of 12–14 scales, 6–10 with canals, mode 9, 1–3 subserial pores. Lower lateral line without canals in most specimens, consisting of 5–8, usually 6–7 pored scales, except in four specimens which have 1 canal and 6 or 7 pores. Lower lateral line continued on caudal fin only in four specimens, which have one caudal-fin pore. One fourth of caudal fin scaled in 3–5 vertical rows. Cephalic lateralis pores generally arranged as illustrated in Fig. 8, but only three infraorbital lateralis foramina in *A. staecki*. Fin counts: D. XV. 5 (1), XV. 6 (1), XVI. 5 (5), XVI.

5i (4), XVI. 6 (16), XVII. 6 (1). A. III. 5i (3), III. 6 (20), III. 6i (5). P. 11 (9), 12 (19).

Dorsal-fin spines subequal in length from 5th. Lappets slightly pointed. Some males grown up in aquaria have moderately long, pointed or slightly produced lappets, but not as produced as in, e. g., *A. cacatuoides* Hoedeman. Lappets of 4th–6th spine longest. Caudal fin rounded (females and small males), subtruncate or with short streamers (adult males). Streamers produced by elongations of 4th and 5th ray in each lobe. Pelvic fin short in females, reaching to first anal-fin spine. In male holotype first pelvic-fin ray reaching to second anal-fin spine; in big males grown up in aquaria (ZFMK 13411 & 13466) first ray produced, reaching to base of third anal-fin ray. Soft part of anal and dorsal fin reaching to first quarter of caudal fin in females, to first third in males.

Jaw teeth subconical, slightly recurved, in two rows in each jaw; about 36 teeth in first row of both jaws (from holotype). Pharyngeal teeth regularly arranged, anterior teeth simple, slightly recurved, posteriormost inner teeth biggest, bicuspid (from ZFMK 13404).

Table 1: Morphometry of *Apistogramma staecki* sp.n.; n = number of specimens; range gives minimum-maximum value in sample; all measurements as per cent of SL.

Measurement	n	Mean	Range
Head length	28	32.7	30.0–34.6
Head depth	28	27.6	25.2–29.6
Body depth	28	34.0	32.4–36.4
Predorsal length	28	35.6	33.8–38.0
Prepelvic length	28	41.7	38.7–44.9
Orbit diameter	28	14.3	13.5–16.0
Snout length	28	3.7	2.4– 5.1
Cheek depth	28	6.0	5.3– 6.5
Head width	28	19.6	18.3–20.6
Interorbital width	28	9.7	8.8–10.3
Preorbital depth	21	1.9	1.5– 2.2
Upper jaw length	28	11.0	10.2–12.0
Lower jaw length	28	14.5	13.0– 16.0
Postorb. head length	28	16.0	14.1–17.6
CPD	28	16.3	15.2–17.3
CPL	28	12.0	11.0–12.6
Dorsal base length	28	60.5	56.7–62.6
Anal base length	28	22.8	21.0–24.9
Pectoral fin length	28	30.7	26.9–33.3
Pelvic spine length	28	15.7	13.7–17.0
Pelvic ray length	28	30.1	27.2–34.1
Last D spine length	28	15.3	12.8–16.9
Last A spine length	28	17.8	16.5–19.2



Vertebrae 12 + 12 (18) or 12 + 13 (3). No preopercular serrations detectable in any specimen. First ceratobranchial with 1–4 external gill-rakers.

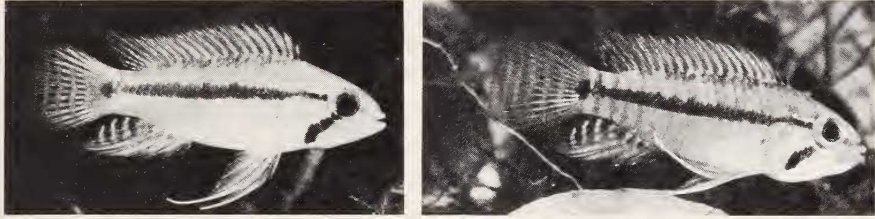


Fig. 2 (left side): Territorial male of *Apistogramma staecki* n. sp. — Fig. 3 (right side): Male involved in lateral display. — Photos: H. Linke.



Fig. 4: Female of *Apistogramma staecki* n. sp. in breeding pattern. — Photo: I. Koslowski.

Coloration (preserved specimens): Pale brownish, with dark brown to blackish or reddish markings. No distinct bars, except in posterior part of the body, leaving dark spots at dorsal-fin base in most specimens, sometimes forming a confluent band. Bar 5, bar 6 and frequently bar 4 split vertically along the middle. In some specimens bars pale reddish; this colour very distinct in freshly preserved specimens, but already faded to brownish during the month of studying the material. A narrow postorbital stripe continued in a narrow lateral band,  $\frac{1}{2}$ – $\frac{2}{3}$  scale deep. Lateral band not distinct in all specimens, most distinct up to where crossed by bar 3, where it is sometimes forming an indistinct small lateral spot. Lateral band not continuous posteriorly, sometimes somewhat intensified where crossed by bars. Moderately wide suborbital stripe, to edge of sub- and interoperculum, broadening posteroventrally. Superorbital stripe absent, only an inconspicuous dark area on forehead in some specimens. Preorbital stripe prominent. A small pectoral spot in upper edge of pectoral axilla. No distinct abdominal stripes developed, but some dark scale rims close to ventral midline. Pale midventral stripe in females, running half distance from vent to pelvic-fin base. Vent spot developed in all specimens. Caudal spot vertically extended, reddish to brownish, with an intensified central portion in most specimens. Dorsal fin

dusky, with reddish to brownish markings between spines basally, dark-edged in some specimens. Soft part with 2 or 3 terminal spot stripes. Anterior one or two spine membranes black. Anal fin similar, dark-edged, with up to 5 terminal spot stripes. Caudal fin with 3–7 very distinct spot stripes, most distinct and numerous in larger specimens, especially in males. Pelvic fins transparent inwards, spine and membranes of first rays darkened outwards, blackish in females, reddish in bigger males, light in small males.

Life coloration: From observations on three males and two females at a size of about 30 mm SL (males) and 25 mm SL (females). Males: Ground colour greyish, whitish in belly region, olivaceous on nape. Males normally show an indistinct lateral band, which becomes more prominent during territorial defence. Lateral band broadening on middle of the body, becoming narrower again posteriorly. Its colour seldomly intensified where crossed by bar 3, then forming an indistinct lateral spot. Band originates in a narrow postorbital stripe. A roundish small caudal spot visible. Suborbital stripe moderately wide, broadening ventrally. In aggressive specimens it can be reduced to an ocellus-like spot at the gill-cover edge. Gill-covers otherwise yellowish in most males. Small bluish spots and stripes below eye, above and below postorbital stripe and above suborbital stripe. Bars not visible, excepting a small dark stripe in bar 7 above lateral band in some specimens and dark areas at dorsal-fin base forming a more or less confluent band. Caudal fin greyish, with 5–7 blackish vertical stripes. Anal fin bright blue, with 4–5 black terminal stripes. First one or two anterior dorsal fin membranes black. Rest of dorsal fin dark greyish basally, bluish in middle part, sometimes with a yellowish edge. Pelvic fins bluish, produced ray with white tip. Vent spot distinct, its dark coloration continued onto basal part of first anal fin membrane. In aggressive specimens involved in lateral display or in courtship the dark caudal fin stripes and terminal spot stripes turn to dark red coloration. Same colour shown in small spots at dorsal and anal fin bases between spines and in bars 4–6, now appearing prominently, bar 5 and 6 showing typical split appearance as in fresh preserved material. Bar 4 distinct only in a small area above and below the lateral band, also split. Edges of dorsal and, more prominent, anal fin darkening in aggressive males.

Females: Exhibit the same dark markings as males and a greyish ground colour when not involved in reproductive activities. Ground colour turns to yellow in prespawning phase, black markings additive to those of the males become distinct. Short midventral stripe and black marginal colour of pelvic fins well visible. In postspawning breeding coloration suborbital stripe, two anterior spines and membranes of dorsal fin, first spine and membranes of the pelvic fins, a narrow marginal line along the anal fin anteriorly and a distinct midventral stripe black. Lateral band almost always faded, but a small indistinct lateral spot or a dusky lateral band may frequently appear. Body and fins bright yellow.

Reproductive behaviour: *Apistogramma staecki* deposit their eggs on the lower surface of plant leaves or on the ceiling of a rock cave. A spawning numbers between 50 and 100 eggs. At a temperature of 24°C the eggs hatch after 72–80 hours. About six days later the fry are free swimming. Both sexes take part in the defence of the territory, but only females take care of eggs and fry. Males are strictly territorial and tend to be polygamous under aquarium conditions, for males frequently had two females caring for their eggs or fry in their territories.

Ecology: "*Apistogramma staecki* was caught in very shallow water (0.2–0.4 m) among dead leaves and wood or, if the water was deeper (0.5–1 m), near the surface among the leaves and roots of floating plants, e. g., *Eichhornia azurea*, *Eichhornia crassipes*, *Pistia stratioides*. It seems remarkable that in contrast to the second *Apistogramma* with which it co-exists this species was not found in less acid water (pH 6.6)" (Staeck, in litt.). Data from the type locality are: pH 5.7, conductivity 94  $\mu\text{S}$  at 29°C; at sta. B 10 with brownish, nearly standing water a total and temporary hardness less than 1° dH, a pH of 6 and a conductivity of 23  $\mu\text{S}$  at 29.5°C was found. Other cichlids collected together with *A. staecki* were *Cichlasoma boliviense* Kullander, *Crenicichla lepidota* Heckel at both localities and *Aequidens cf. vittatus* (Heckel), *Aequidens dorsiger* (Heckel) and *Apistogramma linkei* n. sp. at sta. B 10. Only the *Apistogramma* species were identified by me. The small size of the type specimens indicate a reproductive period at least from April to June.

Distribution: *Apistogramma staecki* is so far known from the Rio Mamoré system in Bolivia and from between Guajara Mirim and Mato Grosso, Brazil.

### *Apistogramma linkei* n. sp.

*Apistogramma amoenus* (nec Cope, 1872): Lüling (1969: 76).

*Apistogramma* sp.: Kullander (1983a: 312).

*Apistogramma* sp.: Linke & Staeck (1984: 113).

Holotype: ZFMK 13323, ♂, 36.9 mm SL; Bolivia, northwest of the town Santa Cruz, Lagunen entlang der Straße zwischen den Orten Portachuelo und Bella Vista, 76 km nordwestlich von Santa Cruz, Wasseransammlungen entlang der Straße und kleiner flacher Wasserlauf der die Straße kreuzt und Lagune an der Straße ca. 2 km östlich vor dem Ort Japacani am Rio Japacani", sta. B 1 und B 2, about 68°25'W–16°20'S and 68°50'W–16°15'S, leg. H. Linke & W. Staeck, VII. 1983.

Paratypes: ZFMK 13324–13327, 2 ♂, 27.7–28.6 mm SL, 2 ♀, 24.9–26.8 mm SL; ZFMK 13328–13362, 35 specimens, 15.0–26.0 mm SL; MZUSP 28726, 8 specimens, 17.7–25.7 mm SL; NRM A 83/1983273.3046, 7 specimens, 16.3–34.7 mm SL; all same data as holotype. ZFMK 13320–13322, 1 ♂, 19.8 mm SL, 2 ♀, 18.5–27.0 mm SL; Bolivia, north-east of the town Santa Cruz, „Bachlauf und kleiner Fluß ca.

4 km vor dem Ort Okinawa westlich von Montero-Guabira in Richtung Rio Grande", sta. B 5, about 62°50'W—17°12'S, leg. H. Linke & W. Staeck, VII. 1983. ZFMK 13363—13367, 3 ♂, 24.1—30.3 mm SL, 2 ♀, 21.1—25.8 mm SL; ZFMK 13368—13393, 26 specimens, 16.0—24.4 mm SL; BMNH 1985, I. 28: 1—5, 5 specimens, 20.1—23.9 mm SL; IRSNB 724, 6 specimens, 18.6—25.0 mm SL; NRM A 83/1983281.3054, 7 specimens, 16.3—25.1 mm SL; ZMA 119.629, 6 specimens, 18.6—23.7 mm SL; Bolivia, west of the town Trinidad, „Lagunen und Restwasser an der Straße von Trinidad nach Westen ca. 1 km vor dem Ort Pto. Amacen am Rio Mamoré", sta. B 9, about 64°58'W—14°53'S, leg. H. Linke & W. Staeck, 11. VII. 1983. ZFMK 13394—13399, 3 ♂, 24.4—27.0 mm SL, 3 ♀, 21.5—24.8 mm SL; Bolivia, east of the town Trinidad, „Lagunen und Restflußwasser an der Straße von Trinidad nach Osten ca. 10 km in Richtung Peroto", sta. B 10, about 64°48'W—14°49'S, leg. H. Linke & W. Staeck, 12. VII. 1983. ZFMK 2268—2273, 6 specimens, 12.8—33.2 mm SL; Bolivia, „teichartiges Altwasser, 1½ km unterhalb San Francisco, linksseitig des Rio Chipiriri", leg. K. H. Lüling, 4. X. 1966. ZFMK 2303, 1 specimen, 25.2 mm SL; Bolivia, „Bach zwischen Rio Chaparé und Rio Mamoré", leg. K. H. Lüling & A. Meyer, 9. X. 1966. NRM A 84/1983166/3061, 1 ♂, 27.2 mm SL, 2 ♀, 19.7—24.2 mm SL; Bolivia, depto. Beni, Rio Mamoré system, Laguna Suarez, near Trinidad, leg. G. Loubens & L. Lauzanne, 23. IV. 1983. NRM A 84/1982118.3062, 2 ♂, 37.5—42.1 mm SL, 3 ♀, 27.6—31.4 mm SL; Bolivia, Depto. Beni, Rio Mamoré system, Arroyo San Juan, near Trinidad, leg. G. Loubens & L. Lauzanne, III. 1982. IRSNB 695 (former IRSNB 19.975), ♀, 25.6 mm SL; Bolivia, depto. Santa Cruz, Rio Guaporé system, road from Ascención, 14 km north of Limón, Rio Surucusi, tributary to the Rio San Miguel, leg. J.-P. Gosse, 9. XI. 1977. Measurements and counts were taken from specimens for which sexes are given.

**Etymology:** The species is dedicated to Mr. Horst Linke, who collected a large part of the type material.

**Diagnosis:** A moderately deep species of the *regani* group (Kullander, 1980b) with slight sexual dimorphism, closely related to *A. commbrae* (Regan) and *A. inconspicua* Kullander, with which it shares a so-called tail spot, formed by the confluence of the caudal spot and the intensified bar 7. Abdominal markings consist of vertical stripes in one to three horizontal scale series below the anterior lateral band, instead of dark spots forming horizontal abdominal stripes. The caudal fin is vertically striped only in the posteriormost part in some specimens. The interorbital is very wide ( $\bar{x} = 9.7$ ,  $n = 28$ ). The lower lateral lines bear one to four canals in 17 of 25 specimens from which counts were taken.

**Description:** Body shape and coloration of preserved and living specimens are given in Figures 5—7. Morphometric data from 28 specimens are summarized in Table 2. The following data are from 28 specimens. Frequency is given in parentheses.

Body shape similar to *A. inconspicua* but slightly deeper. Head slightly shorter, deeper and wider. Sexual dimorphism slight in specimens of same size, restricted to pelvic ray length ( $\bar{x} = 37.8\%$  of SL in males,  $n = 13$ ;  $\bar{x} = 34.2$  in females,  $n = 15$ ) and to dorsal spine length ( $\bar{x} = 18.5$  in males,  $\bar{x} = 17.1$  in females). Males grow bigger (biggest male 42.1 mm SL, biggest female 34.4 mm SL) and then develop more produced soft anal, dorsal and pelvic fins and a coloration very different from females (cf. below).



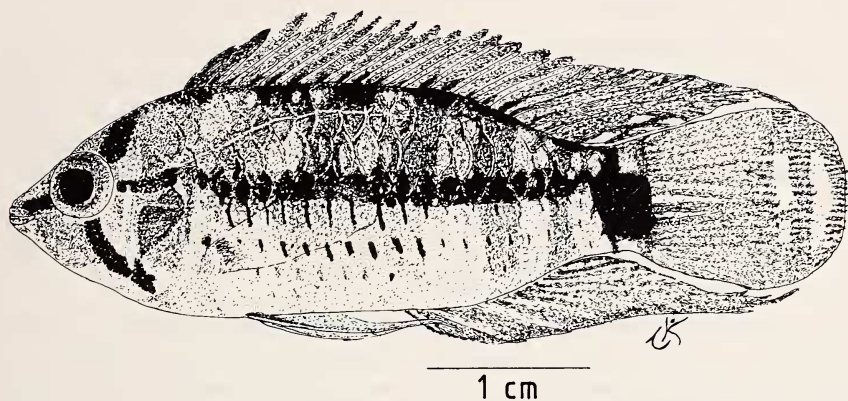


Fig. 5: *Apistogramma linkei* n. sp., sketch of the holotype ZFMK 13323.

Scales in a lateral series 22 (21) or 23 (4). Cheek scales generally arranged in 3 rows, one additional row in large males, restricted to posteroventral corner. Squ. op.: 9 (3), 10 (7), 11 (3), 12 (7), 14 (1), 15 (1); Squ. sop.: 3 (1), 4 (6), 5 (3), 6 (5), 7 (6), 9 (1); Squ. iop.: 3 (27) or 4 (1). Interopercular and anterior subopercular scales deeply embedded under the skin and very difficult to detect. All scales ctenoid except between orbits at predorsal midline, from pelvic fin base anteriorly on chest, on sub- and interoperculum, ventrally on operculum, anteriorly on cheek and posteriorly on caudal fin. Upper lateral line on third scale series above that including lower lateral line, on 11 (1), 12 (4), 13 (6), 14 (8), 15 (7) or 16 (1) scales, 6 (1), 7 (2), 8 (2), 9 (6), 10 (8) or 11 (8) with canals; 1–4 subserial pores. Lower lateral line on 5 (1), 6 (4), 7 (13), 8 (7) scales, with 1 (5), 2 (6), 3 (5), 4 (1) or 0 (8) canals, continued on caudal fin as one pored scale in most specimens. Caudal fin scaled on first quarter in up to eight vertical rows. Cephalic lateralis pores arranged as illustrated in Fig. 8.

Fin counts: D. XV. 6i (1), XVI. 5i (1), XVI. 6 (19), XVI. 6i (5), XVI. 7 (1), XVII. 5i (1). A. III. 6 (22), III. 6i (6). P. 11 (9), 12 (16), 13 (3). Dorsal subequal in length from 5th; lappets short, pointed in males, pointed or truncate in females and small males; third ray longest, to the end of dorsal fin in largest males, to half of caudal fin in biggest female, or not reaching half of caudal fin in smaller males and females. Soft anal fin similar to soft dorsal fin, but in most specimens slightly shorter. Differences in males and females of same size small, in males only slightly more pointed fins. Caudal fin rounded in both sexes. Pectoral fin asymmetrical, 4th–6th ray longest. Pelvic fin short in females and small males, reaching to base of 1st or 2nd anal spine, to base of

first anal ray in largest female, pointed in large males, reaching base of 3rd anal ray in largest specimen.

Jaw teeth subconical, recurved, in 3 rows anteriorly in both jaws, 46/44 teeth in first row of upper/lower jaw in largest specimen. Lower pharyngeal teeth regularly arranged, anterior teeth simple, posteriormost inner teeth biggest, bicuspid or tricuspid. Both shapes found in neighbouring teeth of all three tooth plates examined (from ZFMK 13367, ZFMK 2269 and IRSNB 696).

Free edge of preoperculum serrated in 22 of 27 specimens, 2–18 denticuli,  $\bar{x} = 10.1$  ( $n = 22$ ). First ceratobranchial with 2–4 external rakers. Vertebrae 12 + 12 (21), 12 + 13 (1), 13 + 11 (1), 13 + 12 (1).

Coloration (preserved specimens): Holotype: Pale greyish-brownish with dark brown markings. Bars most distinct above lateral band, broader than interspaces, leaving intensified dark spots at dorsal fin base. Bar 5 and 6 also distinct below lateral band. Bar 7 very intensely pigmented over the whole depth of the caudal peduncle, continuous with an ovalic caudal spot, forming a marking called tail spot by Kullander (1982a). Lateral band originates in a narrow postorbital stripe, about one scale deep, running on the scale series

Table 2: Morphometry of *Apistogramma linkei* sp.n.; for explanation see Tab 1.

Measurement	n	Mean	Range
Head length	28	31.2	29.8–32.3
Head depth	28	28.1	26.4–31.1
Body depth	28	37.1	34.3–40.6
Predorsal length	28	36.5	33.8–39.9
Prepelvic length	28	40.1	37.8–41.9
Orbit diameter	28	12.5	11.5–13.6
Snout length	28	4.9	3.8– 6.2
Cheek depth	28	6.2	4.9– 9.3
Head width	28	18.5	17.1–19.7
Interorbital width	28	9.7	8.9–10.8
Preorbital depth	26	2.7	1.8– 3.6
Upper jaw length	28	10.9	9.5–12.6
Lower jaw length	27	13.6	11.9–14.5
Postorb. head length	28	15.0	13.3–16.6
CPD	28	16.9	15.6–18.3
CPL	28	12.8	11.0–14.8
Dorsal base length	28	61.4	58.4–67.2
Anal base length	28	23.0	21.1–25.0
Pectoral fin length	28	31.9	27.7–34.4
Pelvic spine length	28	15.9	13.9–17.2
Pelvic ray length	28	35.9	28.4–50.9
Last D spine length	28	17.8	16.2–19.5
Last A spine length	28	18.7	16.7–10.2

above that including the lower lateral line, reaching into the tail spot posteriorly. Suborbital stripe to edge of sub- and interoperculum; dorsally interrupted on preoperculum. Moderately wide distinct superorbital stripe running from eye to dorsal midline. Preorbital stripe apparent. A big pectoral spot in upper edge of pectoral axilla. Abdominal markings consisting of vertical stripes, formed by very dark pigment on free skin between every two scales of one scale row, most distinct in first and second horizontal row below lateral band, from pectoral axilla to bar 4, less distinct more posteriorly and in third scale series below lateral band. Dorsal fin dusky with some light spots in soft part posteriorly, but not forming conspicuous terminal spot stripes; anal fin similar. Membranes of two anterior dorsal fin spines black, darker areas at bar origins basally between spines. Caudal fin dusky with some light horizontal stripes just behind tail spot and two light vertical stripes posteriorly. Pectoral fin transparent with some dark pigment basally. Pelvic fins dusky, with spine and membranes of first rays darkened. No distinct midventral stripe. Paratypes: Markings similar to those of holotype, but females and smaller males with distinct midventral stripe. Abdominal markings include dark horizontal stripes in some specimens, formed by dark pigmentation arranged below central portion of each scale, but never as distinct as vertical stripes, which are present in all but one aberrant specimen, in which skin bearing the dark pigment of vertical stripes is lying below and not between scales. Caudal fin immaculate or irregularly dotted in most paratypes. Only big males with one to four vertical stripes posteriorly. Outer pelvic fin darker pigmented in females. Some of the paratypes somewhat faded, but showing most black markings. Lateral band sometimes reduced to spots where crossed by bars. Abdominal markings often faded, but vertical stripes remaining most prominent. Only ZFMK 2303 has lost all pigmentation.

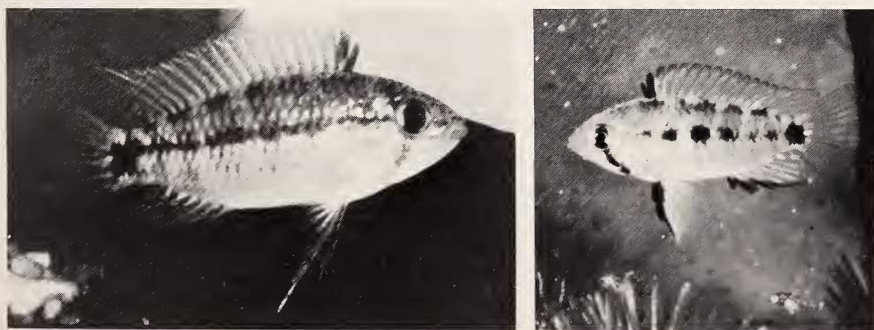


Fig. 6 (left side): Living male of *Apistogramma linkei* n. sp. — Fig. 7 (right side): Female in breeding pattern. — Photos: I. Koslowski.

Life coloration: From observations of several adult males and females. Ground colour of adult males a metallic blue, brownish to olivaceous on nape and back, whitish in belly region. An orange—yellow area on lower operculum and on suboperculum, in some specimens reaching onto body, around pectoral fin base to about fourth vertical scale series behind the base. A lateral band running from eye to tail spot, but most of the time interrupted, then only distinct where crossed by bars. Tail spot most distinct marking in all moods. Bars sometimes visible, especially in aggressive specimens, most distinct above lateral band, bars 4—6 also visible below lateral band. Suborbital and superorbital stripe apparent most of the time, but fading in aggressive specimens. Cheek and gill-covers with lots of blue spots and stripes, some of them reaching into posteroventral orange—yellow area. Scales on nape dark brownish, with distinct light edges. Vertical abdominal stripes most distinct in aggressive specimens. Caudal fin dark greyish between rays, looking like horizontal stripes. Up to four light vertical stripes in posteriormost part and some light spots just behind tail spot. Dorsal fin dark greyish basally and at its edge, bluish in middle part. Anal fin similar. Soft part of anal and dorsal fin with light spots and stripes. One or two anterior dorsal fin spines and membranes black. Dark greyish fin coloration turning to reddish in aggressive specimens. Pelvic fins with a dark spine, bluish on first rays, transparent inwards, produced membrane with a white tip.

Females: Dark markings similar to those of males. Ground colour greyish turning to yellow in prespawning phase. Orange—yellow colour on gill-cover and anterior body missing in females. Breeding pattern of females consisting of black suborbital stripe, black midventral stripe, black outer pelvic fins, dark edged anal fin and two black dorsal fin spines and membranes. Lateral band dark black, almost always spotted, bar 2 to bar 4 spot most distinct, as black as tail spot. Bars often visible above lateral band, especially at dorsal fin base, but never as black as lateral band. Dark vertical abdominal markings apparent during whole reproductive period, most distinct in females defending their brood. No vertical caudal fin stripes shown among females observed.

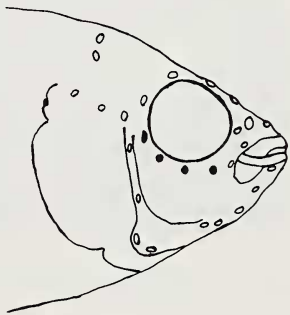


Fig. 8: Arrangement of cephalic lateralis pores in the holotype of *Apistogramma linkei* n. sp., lateral aspect. Anteriormost two mandibular pores not visible in this aspect. Four infraorbital lateralis foramina as black dots below the eye. Other pores as open circles.



**Reproductive behaviour:** *Apistogramma linkei* is a concealment brooder, laying its eggs on the ceiling of rock caves. Females take care of eggs and larvae until the fry is free swimming. At this time the male sometimes takes part in leading the young, while it is only defending the outer territory before. Males sometimes spawn with several females in their territory and, therefore, tend to be polygamous under aquarium conditions.

**Ecology:** A detailed description of habitats of *A. linkei* can be found in Linke & Staeck (1984) and Lüling (1969). Data on sta. B 10 are given in the description of *A. staecki*. *Apistogramma linkei* is found in small lagunas or somewhat deeper pond-like waters, with much floating vegetation. Other cichlids collected together with *A. linkei* are *Apistogramma luelingi*, *Apistogramma staecki*, *Aequidens dorsiger*, *Aequidens* c.f. *vittatus*, *Crenicichla lepidota* and *Cichlasoma boliviense*. Only the *Apistogramma* species were identified by me. Small specimens collected from April to October indicate a breeding period at least from January to September.

**Distribution:** *Apistogramma linkei* is so far known from the Rio Mamoré system, from Santa Cruz in the south to Trinidad in the north and from the nearby Rio Surucusi, a tributary to the Rio San Miguel.

### Discussion

The two new species described in this paper apparently represent different lineages within the genus *Apistogramma*. The relationships of *A. staecki* remain obscure, but its affinities are probably with the *steindachneri* species group. The narrow lateral band, the split bar pattern and the posteroventrally broadening suborbital stripe may be derived character states shared by the three species of the *steindachneri* group. The split bars, typical for all four species, are well visible in freshly preserved material, but they are fading after some time. I was able to observe this process during the month of studying the *A. staecki* material. Therefore, it is understandable, that split bars are not found in specimens of the *steindachneri* group species, preserved for a longer period of time. Living specimens of *A. staecki* as well as of the three species of the *steindachneri* group show the split bars very prominent when in aggressive mood. Moreover they are able to reduce the suborbital stripe to an ocellus-like spot at the gill-cover edge in lateral and frontal display. *Apistogramma steindachneri* (Regan) most closely resembles *A. staecki* since males also develop streamers in the caudal fin and pointed dorsal fin lappets. Differences between *A. staecki* and the species of the *steindachneri* group are summarized in Table 3.

The few lower lateral line canals in *A. staecki* probably to some extent reflect the relative small size of the wild specimens, since I found two and four canals in the two males grown up in aquaria. Kullander (1980b) found pores to be

Table 3: Differences between *Apistogramma staecki* and two species of the *steindachneri* group, *A. steindachneri* and *A. hippolytae*. Data on *A. steindachneri* from five specimens of ZMH 2805, from ZMH 16698 and ZMH 5682 (holotype of *A. wickleri*); data given in parentheses from Surinamese material studied by Kullander (pers. comm.); data on *A. hippolytae* from Kullander (1982b), except maximum size which is from ZFMK 13468 (import specimen from Brazil).

Character	<i>Apistogramma staecki</i>	<i>A. steindachneri</i> / <i>A. hippolytae</i>
Flank spot	absent	present
Lateral band	on and above lower lateral line	distinctly above lower lateral line
Infraorbital lateralis foramina	3	4
Lower lateral line canals	0-4, $\bar{x} = 0.3$ , n = 31	4-6, $\bar{x} = 5$ (3-7, $\bar{x} = 5.1$ ) / 5-7, $\bar{x} = 6$
Opercular scales	12-18, $\bar{x} = 14.3$	9-12, $\bar{x} = 9.8$ (8-12, $\bar{x} = 9.9$ ) / 10-12, $\bar{x} = 11.4$
Subopercular scales	5-11, $\bar{x} = 8.3$	3-4, $\bar{x} = 3.2$ (2-4, $\bar{x} = 3.2$ ) / 3-4, $\bar{x} = 3.7$
Maximum size of aquarium raised specimens	32.1 mm SL	75.6 mm SL / 43.0 mm SL

Table 4: Differences between *Apistogramma linkei*, *A. commbrae* and *A. inconspicua*. Data on *A. commbrae* from personal examination of five specimens (BMNH 1900.4.14:16, lectotype; BMNH 1895.1.30:6-7; BMNH 1935.6.4:466-467) and from Kullander (1982a), in parentheses. Data on *A. inconspicua* from personal examination of two specimens (NRM A82/3405; ZMH 5686) and from Kullander (1983a), in parentheses.

Character	<i>A. linkei</i>	<i>A. commbrae</i>	<i>A. inconspicua</i>
Interorbital width	$\bar{x} = 9.7$	$\bar{x} = 8.3$ (8.1)	$\bar{x} = 8.2$ (7.8)
Dorsal spine number	$\bar{x} = 16.0$	$\bar{x} = 16.0$ (16.1)	$\bar{x} = 15.0$ (15.0)
Abdominal stripes	distinct vertical stripes	distinct horizontal spot stripes	Inconspicuous horizontal spot stripes
Caudal fin stripes	only in posterior part of fin	on whole fin length in middle part of fin	on whole fin length over whole fin depth
Lateral band	running into tail spot	running into tail spot	ending in bar 6

the ontogenetic precursor of canals in *Apistogramma*. Nevertheless, even a count of four lower lateral line canals is low in contrast to those of similar-sized species of the *steindachneri* group, but low counts for lower lateral line canals are typical for *Apistogramma* species with a southern distribution (cf. Kullander 1982a).

*Apistogramma eunotus* Kullander, a *regani* group species from Peru, has been described as having bar 6 split vertically below the lateral band, but *A. eunotus* is otherwise very distinct from *A. staECKi* in body shape and coloration.

The localities of *A. staECKi* in the Rio Mamoré are distant from those of the potentially related *steindachneri* group species in the Rio Negro and Lake Manacapuru (*A. hippolytae*) and in the Guianas [(*A. steindachneri*, *A. rupununi*<sup>2</sup> (Fowler)], but the Rio Madeira system uniting both areas is far from well collected.

*Apistogramma linkei* is a species of the *regani* group, species of which are characterized by a lateral band without lateral spot, rather prominent bars and only slight sexual dimorphism. The tail spot apparent in *A. linkei* seems to be synapomorphic with the spot visible in two other species of the *regani* group, *A. inconspicua* from the Guaporé and Paraguay basin and *A. Commbrae* from the Paraguay basin. All three species are quite similar to each other in regard to other aspects. Differences between the three forms are summarized in Table 4.

*Apistogramma inconspicua* was described having tricuspid teeth on the lower pharyngeal tooth plate and Kullander stressed this as a difference to *A. commbrae* and *A. linkei*. The finding of tricuspid and bicuspid shape in neighbouring teeth on all three pharyngeal tooth plates of *A. linkei* studied by me, including the one figured in Kullander (1983a, Fig. 9) indicates that the taxonomic relevance of this character should be treated with some caution and that more detailed studies of pharyngeal teeth in *Apistogramma* species are necessary.

It is interesting that *A. inconspicua*, which is distributed between the known ranges of *A. commbrae* and *A. linkei* is not intermediate between these forms in most aspects, as one would expect. *A. linkei* and *A. commbrae* are more similar to each other than to *A. inconspicua* in, e. g., lateral band pattern, caudal fin coloration and dorsal spine number.

Aquarium imports from the Paraguay region indicate that there may be more than three species in this group. One must await more collections from

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<sup>2</sup> *Apistogramma rupununi*, treated as a synonym of *A. steindachneri* in Kullander (1980b), turned out to be a valid species, according to reexamination of the type material (Kullander, pers. comm.). It may be conspecific with the „Zweifleck-Apistogramma“ (cf. Kullander 1982b).

the upper Paraguay and Guaporé basin before relationships can be discussed with more security.

The relationships of the three tail-spot forms with other species of the *regani* group must remain unsolved at present, but it should be mentioned that a species so far known only from aquarium imports from the Paraguay region features a marking very similar to the tail spot. In this species the lateral band is running into bar 7, which is distinctly pigmented over the whole vertical of the caudal peduncle and only slightly separated from an ovalic caudal spot.

*Apistogramma nijsseni* Kullander, a Peruvian species also featuring a tail spot, is very different in other respects, e. g., in lacking a lateral band but showing a large lateral spot. It is certainly not closer related to the other three tail-spot forms.

*Apistogramma luelingi*, the third species of the genus inhabiting the Rio Mamoré system is easily distinguishable from *A. linkei* on body shape and colour pattern alone, but is superficially similar to *A. staecki* in body shape at least in small specimens. Both have a well-scaled operculum and suboperculum, some similar colour marks and reduced lower lateral line. They differ strikingly in anal fin spine number, i. e., 3 in *A. staecki* (also in *A. linkei*), but 4, rarely 5 or 6 in *A. luelingi*. Reexamination of the three-spined specimen of *A. luelingi* (ZFMK 2303) reported by Kullander (1976) shows that it belongs to *A. linkei*; a six-spined specimen from the upper Guaporé recorded by Kullander (1976, 1980b) I found to agree with *A. luelingi* in almost all respects and a single specimen with five spines is known from fresh material (ZFMK 13318) of *A. luelingi*.

Cephalic lateralis pores in *Apistogramma* species were figured recently in Kullander (1980b, p. 32). I found differences in their number in *A. staecki* on the one hand and in species of the *steindachneri* group and *A. linkei* on the other hand. Species of the *steindachneri* group show an arrangement as figured for *A. linkei* (Fig. 8), but *A. staecki* is characterized by the reduction of the infraorbital series to three pores. Reductions of infraorbital pores were also found in species of the *agassizii* group, the *gibbiceps* group, the *pertensis* group (but not in *A. pertensis* (Haseman) itself) and in *A. cacatuoides* and *A. luelingi*; all species of the *macmasteri* group and the *regani* group examined by me have four infraorbital lateralis foramina (all groups defined in Kullander 1980b). A discussion of this character must await a detailed examination of head pores and underlying osteology in all *Apistogramma* species of which material is available.

It has been stressed that *A. staecki* seems to occur only in more acid waters, whereas *A. linkei* is also found in waters with an alcalicid pH (Linke & Staeck 1984). Lüling also collected *A. linkei* in alcalicid waters, whereas *A. luelingi* seems to inhabit only acid waters in the Todos Santos area (Lüling 1969). It



is interesting that *A. linkei* seems to tolerate greater differences in pH-values and lives sympatrically with *A. luelingi* and *A. staecki*, whereas those two species seem to prefer acid waters and have not been collected together so far. This indicates concurrency between the two species, but more collections from other places in the Rio Mamoré system are necessary before this can be discussed in detail.

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### Zusammenfassung

Zwei neue Arten der Gattung *Apistogramma* werden aus dem Rio Mamoré System in Bolivien beschrieben. — *Apistogramma staecki* n.sp. ist eine Art mit ausgeprägten Geschlechtsunterschieden in der Beflossung und wird durch senkrecht gespaltene Querbinden 5 und 6, gelegentlich auch 4 in frisch konserviertem Material charakterisiert. Dieses Merkmal teilt sie mit Arten der *steindachneri* Gruppe aus dem mittleren Amazonasgebiet und den Guayana-Ländern. Von diesen unterscheidet sich *A. staecki* zum Beispiel durch das Fehlen eines Flankenflecks, einer höheren Anzahl operkulärer Schuppen und die geringere Anzahl von Kanälen in der unteren Seitenlinie. — *Apistogramma linkei* n.sp. gehört zur *regani* Gruppe und ist nahe mit *Apistogramma commbrae* und *Apistogramma inconspicua* verwandt. Die drei Arten weisen als gemeinsames abgeleitetes Merkmal einen sogenannten Schwanzfleck auf. *Apistogramma linkei* unterscheidet sich von den beiden anderen Arten unter anderem durch das Vorhandensein deutlicher vertikaler Striche anstelle von Längsstreifen als Abdominalmarkierungen und eine wesentlich größere Interorbitalbreite. Die Schwanzflosse ist außerdem nur in ihrem hinteren Randbereich vertikal gestreift. — Die dritte im Rio Mamoré System vorkommende Art, *Apistogramma luelingi*, kann von den beiden neu beschriebenen Arten leicht anhand der größeren Zahl an Afterflossenstacheln (4 oder mehr anstelle von 3) unterschieden werden.

### Resumen

Se describen dos especies del género *Apistogramma* de sistema hidrográfico del Rio Mamoré en Bolivia. — *Apistogramma staecki* n. sp. es una especie caracterizada por un notable dimorfismo sexual en las aletas y por el hecho de que las bandas verticales

5 y 6 (a veces también la banda 4) aparecen divididas verticalmente en material recién conservado. Esta característica la comparte con especies del grupo *steindachneri* de la Amazonía central y de las Guayanas. De estas últimas *A. staecki* difiere por ejemplo por la falta de una mancha en los flancos, por poseer mayor cantidad de escamas operculares y por su menor número de canaliculos en la línea lateral inferior. — *Apistogramma linkei* n. sp. pertenece al grupo *regani* y está cercanamente emparentado con *A. commbrae* y *A. inconspicua*. Estas tres especies tienen la característica derivada, de poseer una así llamada mancha caudal. Pero entre ellas *A. linkei* se caracteriza por la presencia de líneas verticales conspicuas en vez de estriás horizontales como marcas abdominales. Además tiene una distancia interorbital notablemente mayor. La aleta caudal tiene estriás verticales sólo en su borde posterior. — La tercera especie de este género presente en el sistema del Río Mamoré, *Apistogramma luelingi*, es fácil de diferenciar de las dos nuevas especies por su mayor cantidad de espinas en la aleta anal (4 o más en vez de 3).

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